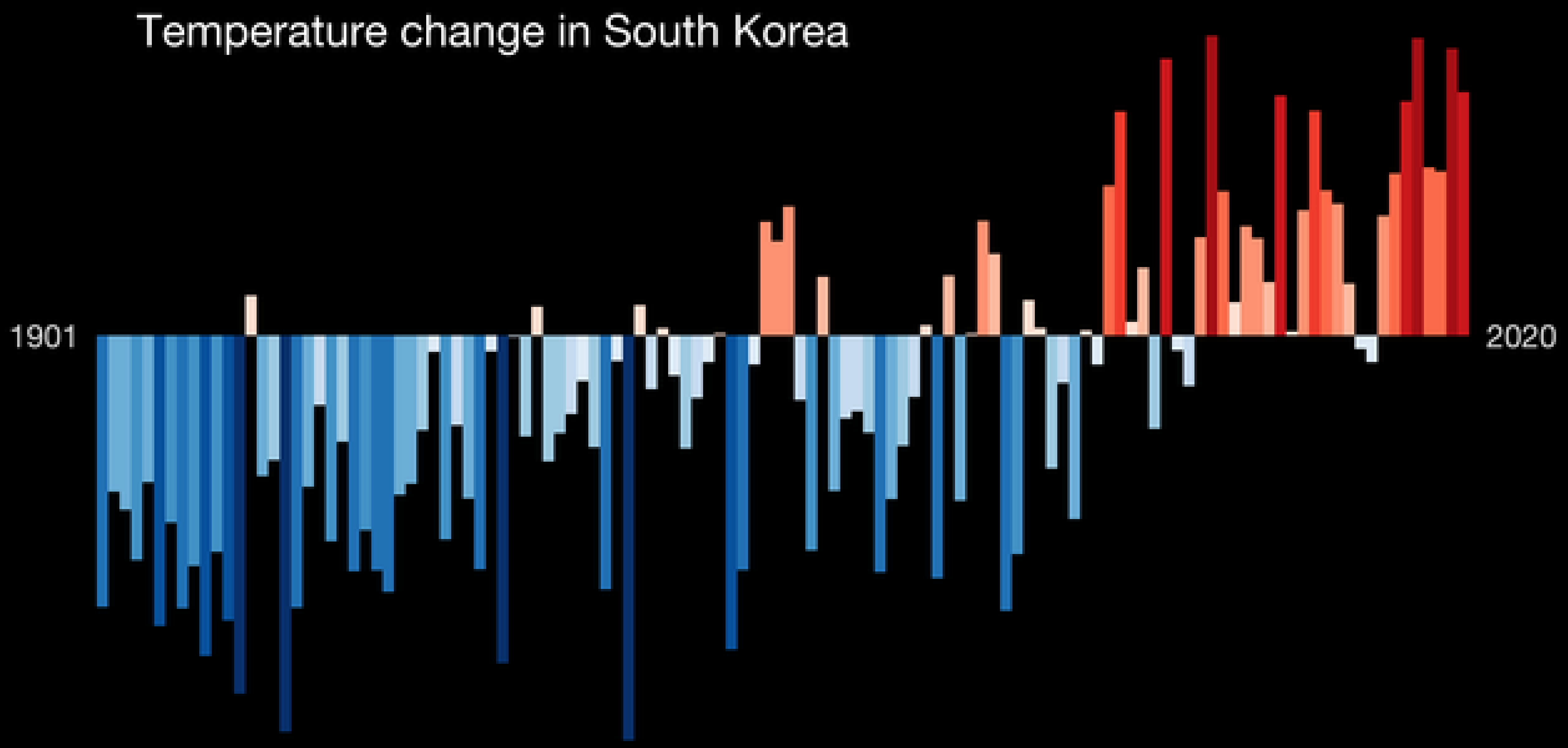
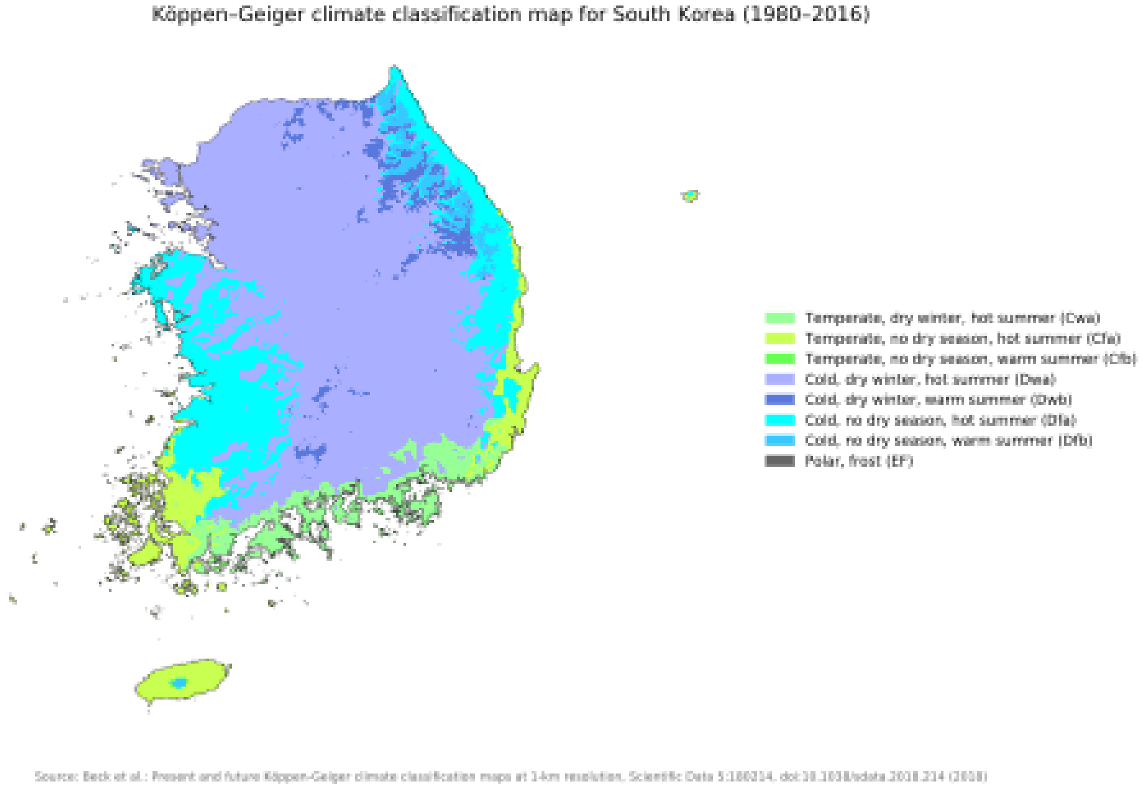
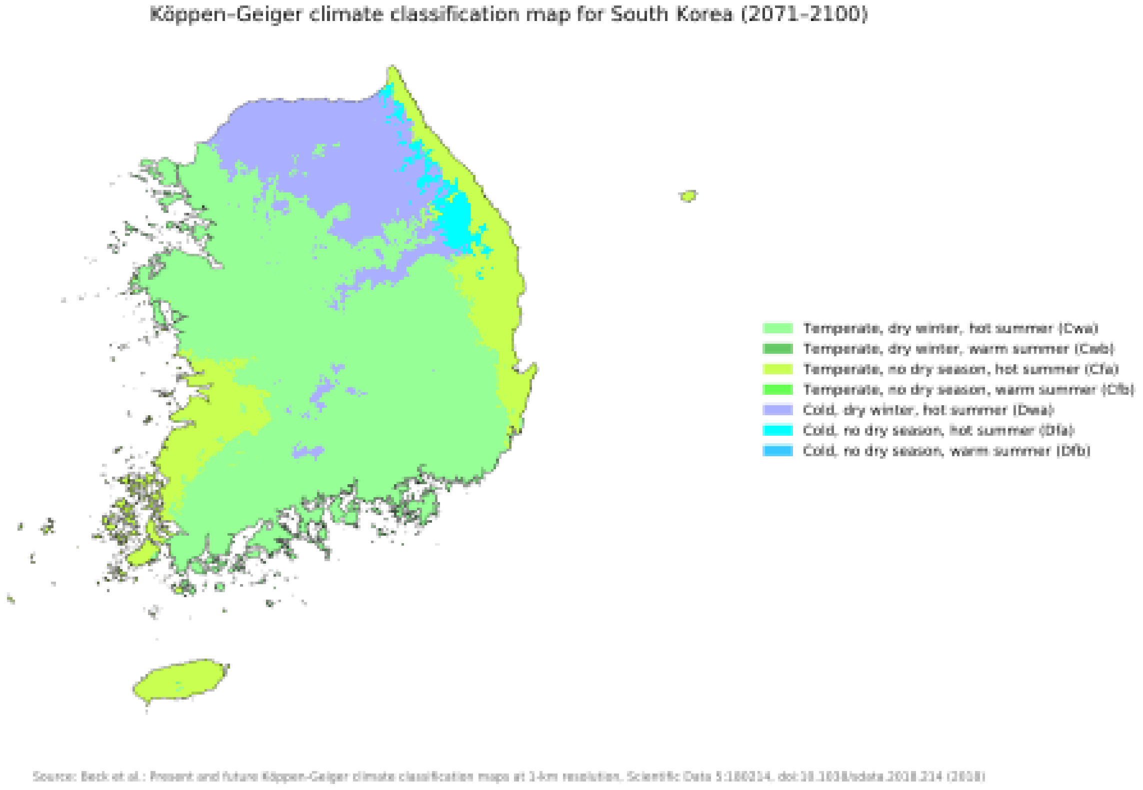
Building Energy of Seoul, Korea


Temperature change in South Korea
1901
2020

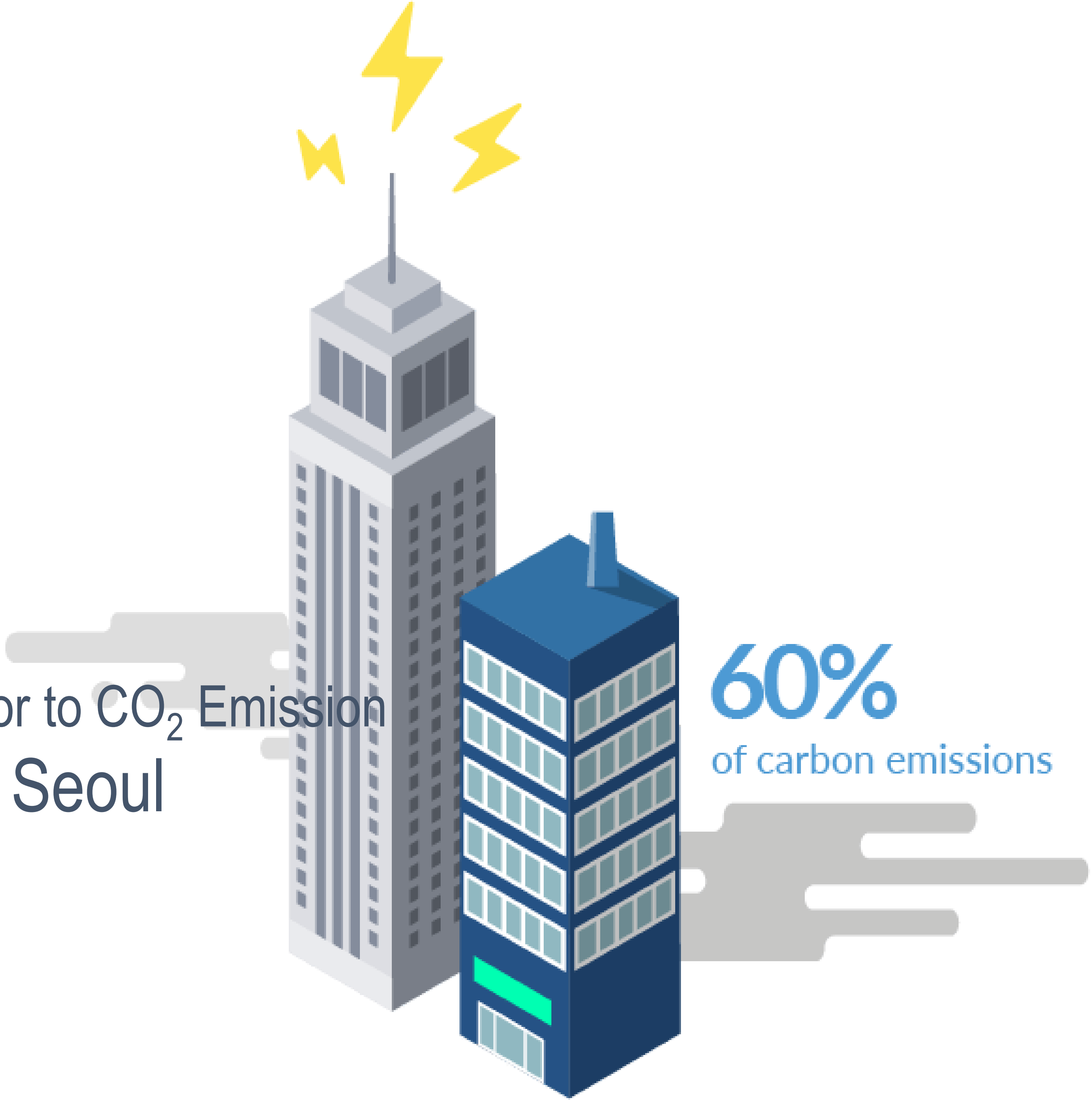

Köppen-Geiger climate classification map for South Korea (1980-2016)
Temperate, dry winter, hot summer (Cwa)
Temperate, no dry season, hot summer (Cfa)
Temperate, no dry season, warm summer (Cfb)
Cold, dry winter, hot summer (Dwa)
Cold, dry winter, warm summer (Dwb)
Cold, no dry season, hot summer (Dfa)
Cold, no dry season, warm summer (Dfb)
Polar, frost (EF)
Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution. Scientific Data 5:180214. doi:10.1038/sdata.2018.214 (2018)

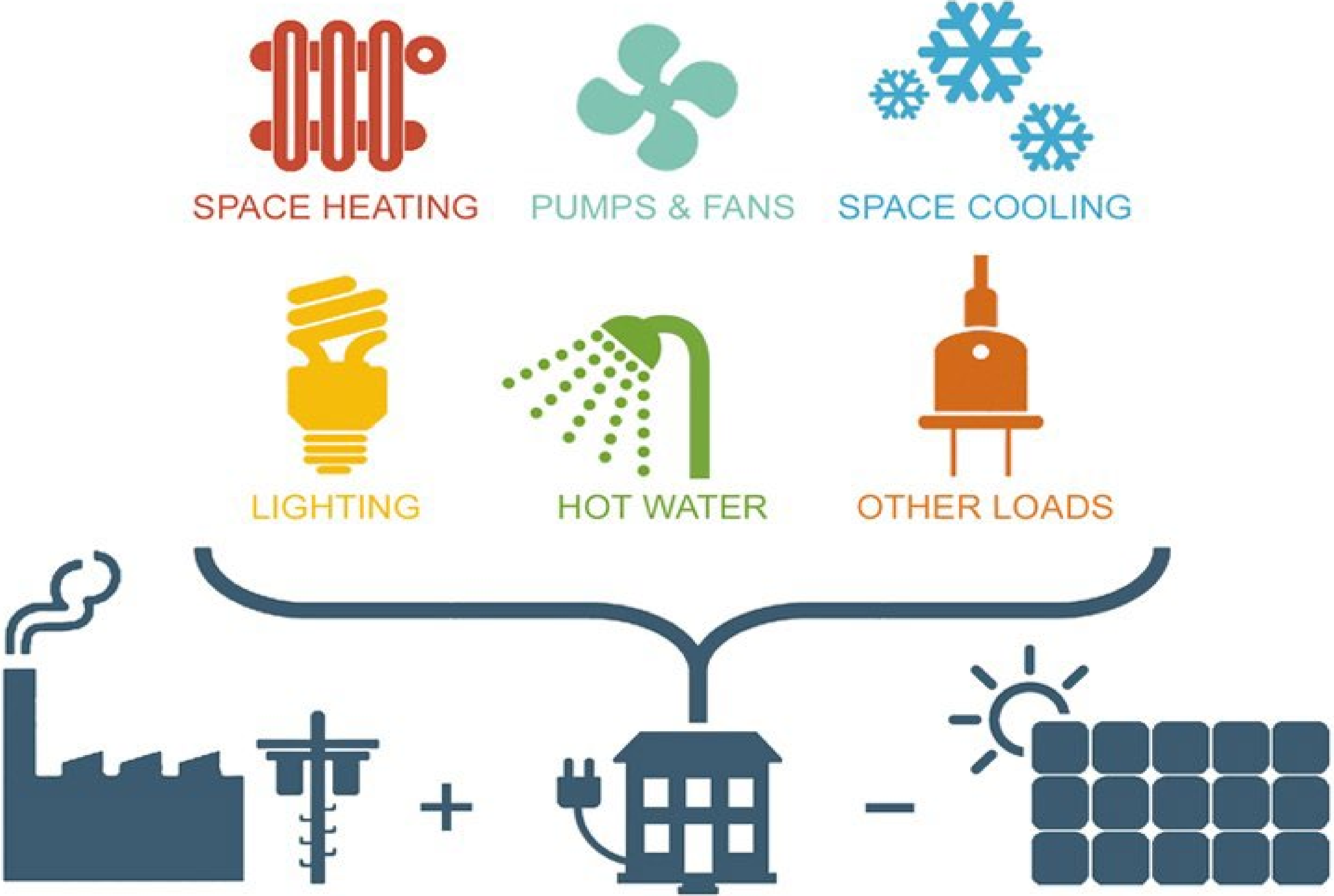

Köppen-Geiger climate classification map for South Korea (2071-2100)
Temperate, dry winter, hot summer (Cwa)
Temperate, dry winter, warm summer (Cwb)
Temperate, no dry season, hot summer (Cfa)
Temperate, no dry season, warm summer (Cfb)
Cold, dry winter, hot summer (Dwa)
Cold, no dry season, hot summer (Dfa)
Cold, no dry season, warm summer (Dfb)
Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution. Scientific Data 5:180214. doi:10.1038/sdata.2018.214 (2018)

Climate Change Intensifying Water-Related Disasters

The buildings sector is a key contributor to CO_2 Emission

Over 60% of CO_2 Emission in Seoul




SPACE HEATING
PUMPS & FANS
SPACE COOLING
LIGHTING
HOT WATER
OTHER LOADS
+
−

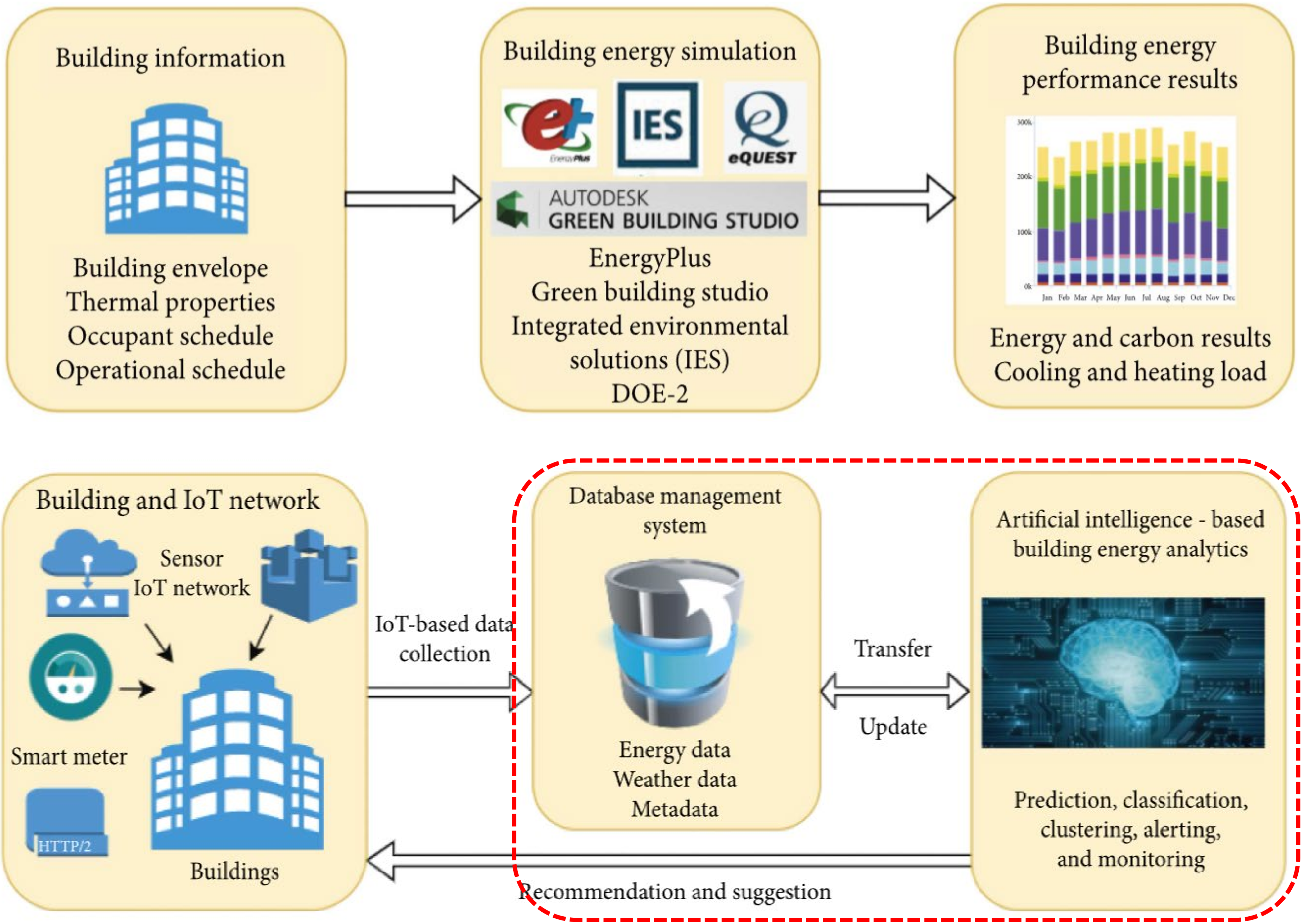
1. How much energy is used in buildings?

$\downarrow$ Energy Prediction

2. How can we reduce energy consumption in a building?

$\downarrow$ Future Energy Scenarios

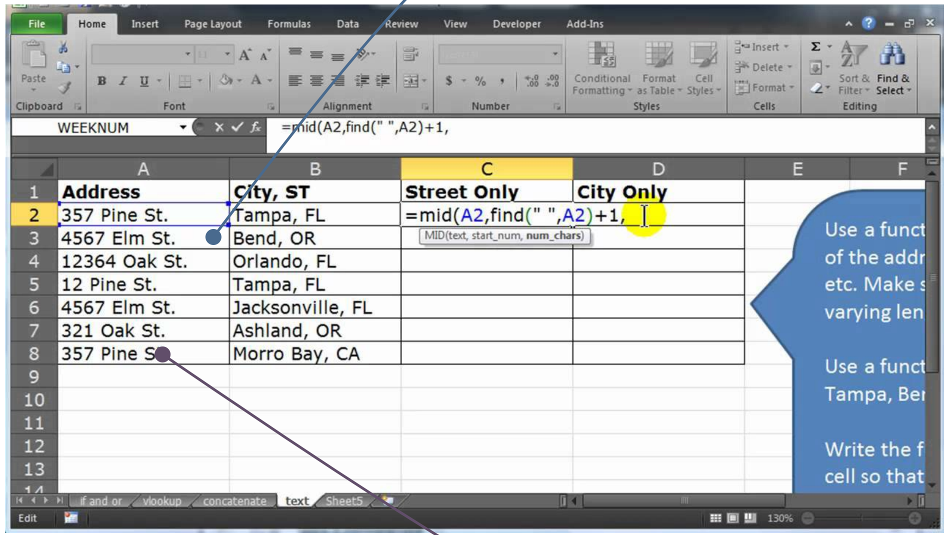
3. Decision Making



Building information
Building envelope
Thermal properties
Occupant schedule
Operational schedule
Building energy simulation
IES
eQUEST
AUTODESK
GREEN BUILDING STUDIO
EnergyPlus
Green building studio
Integrated environmental solutions (IES)
DOE-2
Building energy performance results
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Energy and carbon results
Cooling and heating load
Building and IoT network
Sensor
IoT network
Smart meter
HTTP/2
Buildings
IoT-based data collection
Database management system
Energy data
Weather data
Metadata
Transfer
Update
Artificial intelligence - based building energy analytics
Prediction, classification, clustering, alerting, and monitoring
Recommendation and suggestion

Urban Building Energy Prediction & Peer Group Development

From Article, “Using Urban Building Energy Modeling to Develop Carbon Reduction Pathways for Cities”



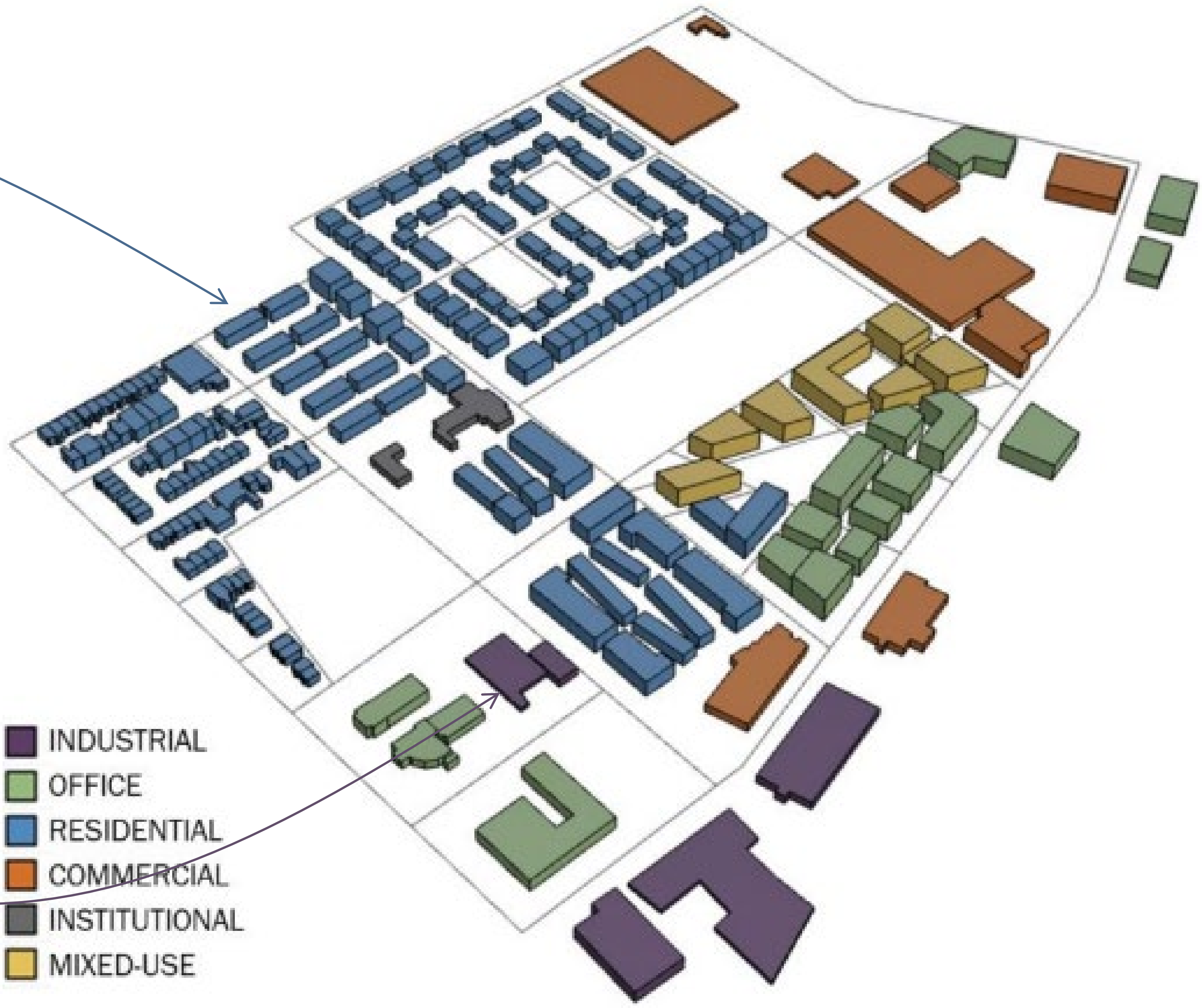
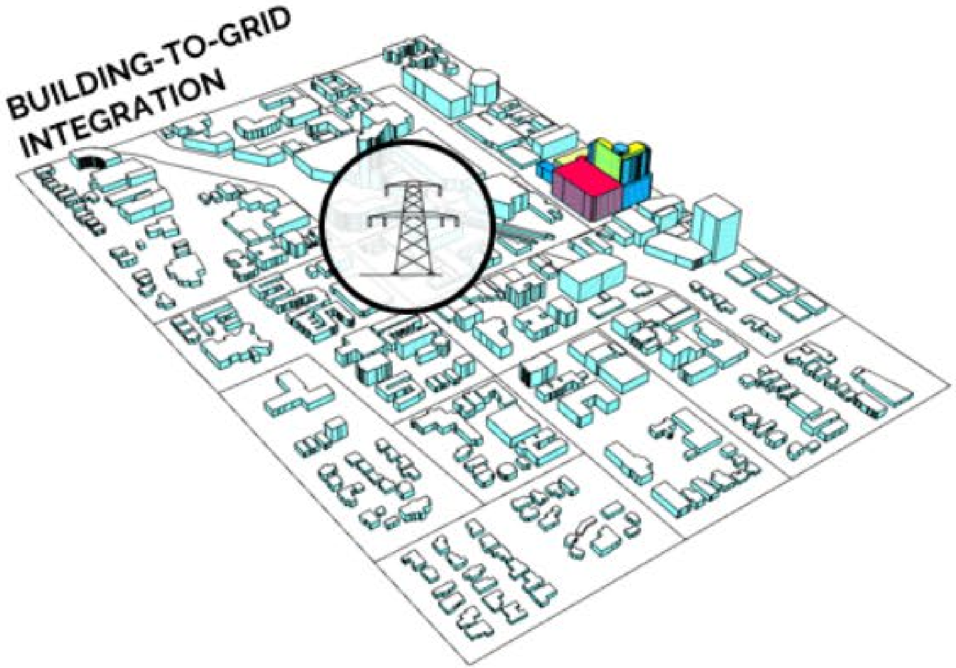
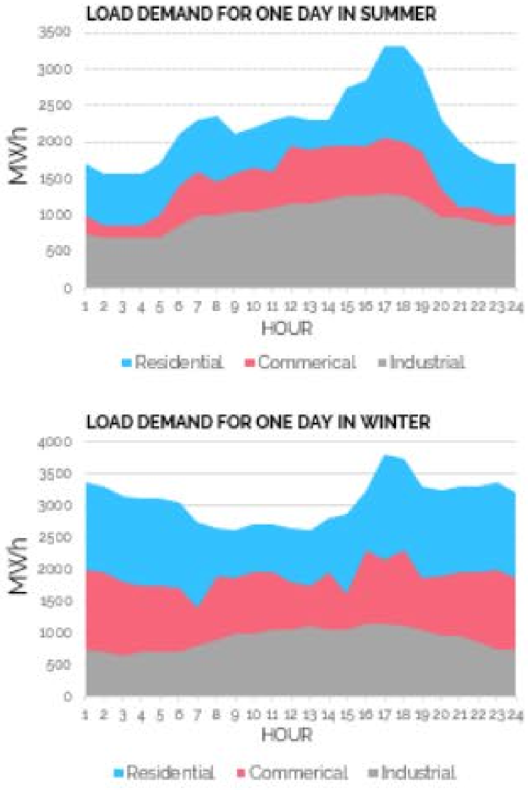


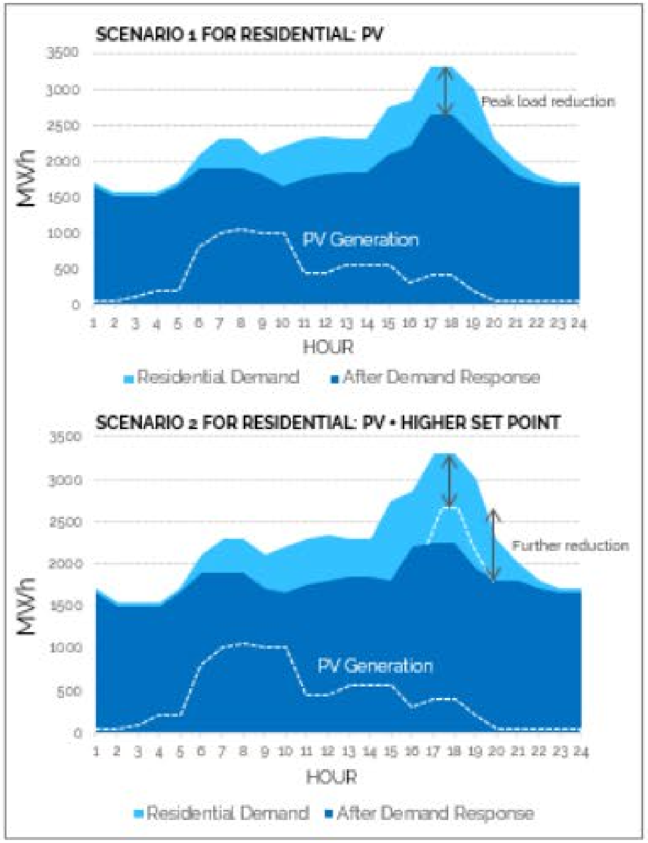
Figure 6-2: Graphic rendering of the neighborhood. Buildings are colored according to their programmatic usage. Circled blocks in pink identify buildings emphasized in scenario A and B.

Table 6-5: Summary of key UBEM input parameters.

Land Use	Industrial	Residential	Institutional		Commercial		Mixed-Use
Archetype	Warehouse	Residential	Kindergarten	Office	Restaurant	Retail	Mixed-Use
Average WWR	0.20	0.30	0.40	0.40	0.50	0.50	0.40
Wall U (W/m^2K)	0.62	0.62	0.62	0.52	0.52	0.52	0.52
Roof U (W/m^2K)	0.38	0.38	0.38	0.28	0.28	0.28	0.28
Window U (W/m^2K)	3.12	3.12	3.12	2.72	2.72	2.72	2.72
Glazing SHGC	0.76	0.76	0.76	0.69	0.69	0.69	0.69
Infiltration (ACH)	0.15	0.15	0.15	0.10	0.10	0.10	0.10
Occupants (pp/m^2)	0.015	0.028	0.050	0.050	0.086	0.086	0.050
Equipment (W/m^2)	15.0	5.0	2.5	7.5	5.0	2.5	7.5
Lighting (W/m^2)	9.7	6.5	15.1	9.7	15.1	15.1	9.7
DHW ($m^3/h/m^2$)	0.0001	0.0005	0.0002	0.0002	0.0005	0.0001	0.0002
Heat set-point (°C)	21	22	22	21	21	21	21
Cool set-point (°C)	24	24	24	24	24	24	24
Ventilation ($m^3/s/pp$)	-	-	0.0025	0.0025	-	-	-
Ventilation ($m^3/s/m^2$)	0.0003	-	0.0003	0.0003	0.0006	0.0003	0.0006


BUILDING-TO-GRID
INTEGRATION


LOAD DEMAND FOR ONE DAY IN SUMMER
MWh
HOUR
Residential
Commerical
Industrial
LOAD DEMAND FOR ONE DAY IN WINTER
MWh
HOUR
Residential
Commerical
Industrial


SCENARIO 1 FOR RESIDENTIAL: PV
Peak load reduction
PV Generation
MWh
HOUR
Residential Demand
After Demand Response
SCENARIO 2 FOR RESIDENTIAL: PV + HIGHER SET POINT
Further reduction
PV Generation
MWh
HOUR
Residential Demand
After Demand Response

Urban Modelling Interface(UMI, MIT개발)

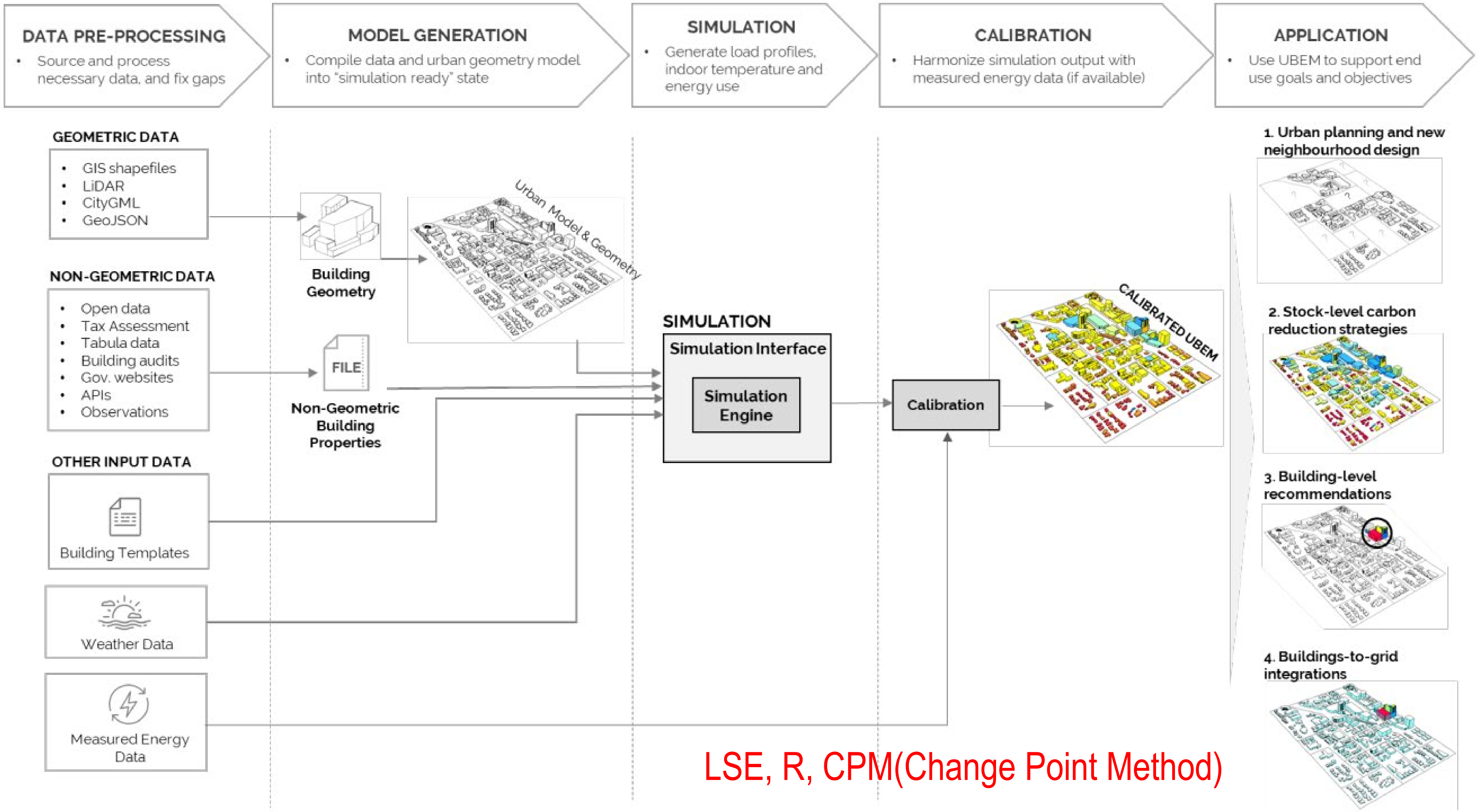


Figure 2-1: UBEM workflow, processes, and data streams.

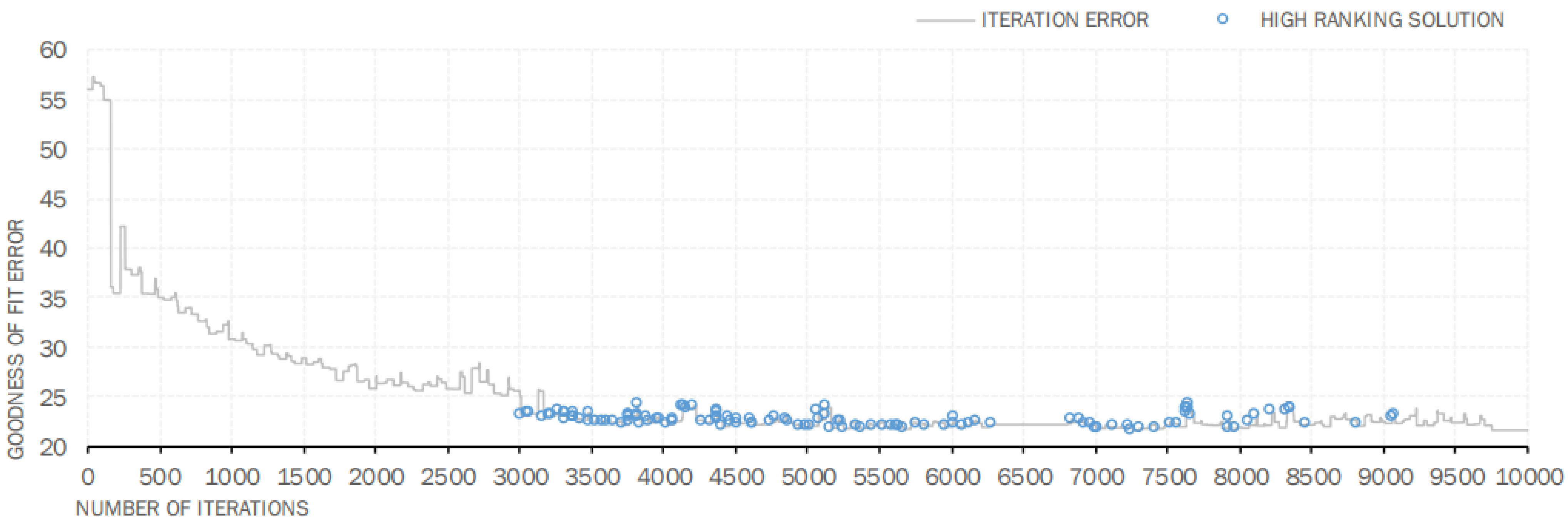
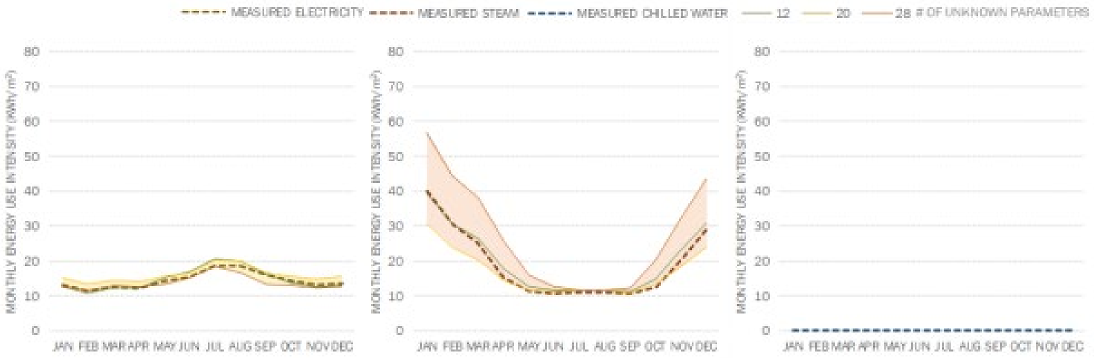
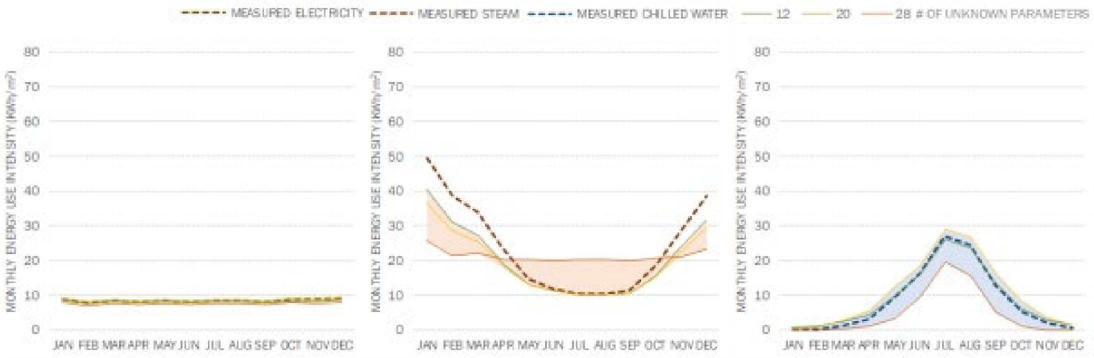


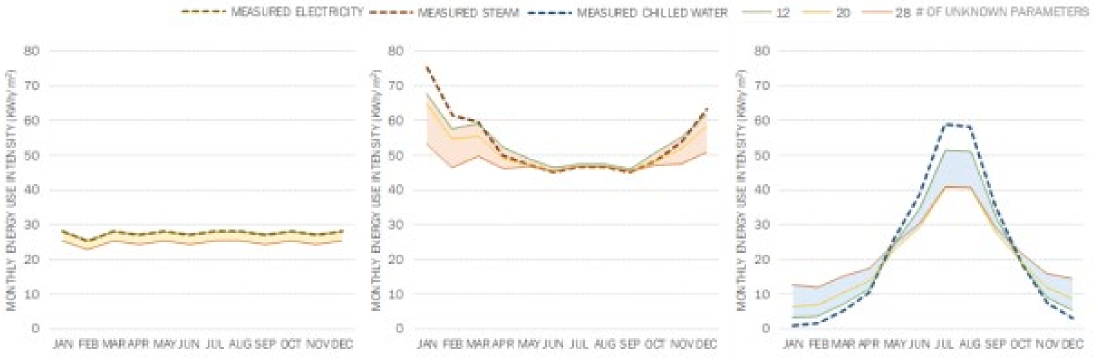
Figure 7-1: *Graphic representation of the optimization process output, highlighting 100 high-ranking solutions.*



(a) Residential Building



(b) Academic Building



(c) Laboratory Building